



George C. Marshall Space Flight Center  
Marshall Space Flight Center, Alabama 35812

**QD-QA-009**  
**REVISION H**

**EFFECTIVE DATE: November 22, 2005**

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# **ORGANIZATIONAL INSTRUCTION**

# **PENETRANT INSPECTION**

OPR(s)

QD10, QD20, QD30, and  
QD40

OPR DESIGNEE

Bobby Rains

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## DOCUMENT HISTORY LOG

Status (Baseline/ Revision/ Canceled)	Document Revision	Effective Date	Description
Baseline		10/17/97	
Revision	A	02/08/99	General Update
Revision	B	05/15/99	Add MSFC-STD-1249 to Applicable Documents
Revision	C	07/01/99	Changes made to reflect new organization code changes and/or changes made to reflect new directives renumbering scheme and to incorporate the corrective action of NCR 266
Revision	D	03/8/00	Made changes to reflect moving MSFC-STD-1249, "Standard NDE Guidelines and Requirements for Fracture Critical Programs", ANSI/AWS D1.1, "Structural Welding Code", and ASME Section V, "Nondestructive Examination" to sections 2.0, paragraph 2.2.
Administrative	N/A	8/28/00	OPR and/or OPR Designee change due to personnel transfer or other administrative reason. No other change to the document has been made.
Revision	E	9/05/02	Format and numbering change to implement requirements of QS-A-001 rev F.
Revision	F	05/05/03	Changes made to reflect new organization and electronic forms. Revised document reference in Applicable Documents. Updated sections 4.1.1 and 4.4.2 for additional clarifications. Changed language in note in section 9.
Revision	G	10/1/04	Revised to bring document in compliance with the HQ Rules Review Action (CAITS: 04-DA01-0387). Changes were also made to reflect S&MA organizational name changes (i.e., QS to QD).
Revision	H	11/22/05	Administrative Revision, changed OPR

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## PENETRANT INSPECTION

### 1. PURPOSE, SCOPE, APPLICABILITY

1.1. Purpose – This instruction complies with MPR 8730.1.

1.2. Scope – This instruction provides general requirements for penetrant inspection of flight hardware, structural welded assemblies, subassemblies, components, pressure vessels, and pressure boundaries. Penetrant inspection shall be performed using fluorescent and visible water-washable penetrant, and visible and fluorescent solvent removable penetrant.

1.3. Applicability – This instruction is applicable to all MSFC Safety and Mission Assurance (S&MA) personnel who perform penetrant inspection.

### 2. DOCUMENTS

#### 2.1. Applicable Documents

ASTM E 1417	American Society for Testing and Materials (ASTM), Standard Practice for Liquid Penetrant Examination
MPR 8730.1	Inspection and Testing
MWI 3410.1	Personnel Certification Program

#### 2.2. Reference Documents

The following reference documents provide additional information concerning the subject of Penetrant Inspection:

ANSI/AWS D1.1	Structural Welding Code
ASME Section V	Nondestructive Examination
MSFC-STD-1249	Standard NDE Guidelines and Requirements For Fracture Critical Programs

### 3. DEFINITIONS

Refer to **ASTM E 1417** for applicable definitions.

### 4. INSTRUCTIONS

#### 4.1 Restrictions

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4.1.1. Dye penetrant shall not be used on weldments subject to radiographic inspection until after the weldment has been radiographically inspected.

4.1.2 Penetrant inspection shall initially be performed prior to application of plating, painting, buffing, or similar processes.

4.1.3 Penetrant inspection shall be performed after forming, heat treating, or similar processes which may adversely affect the material.

4.1.4 Inspection shall be performed in a well ventilated area.

4.1.5 Consideration shall be given to the consequences of entrapped penetrant materials, because cleaning of the part may not be possible.

4.2. Compatibility With Liquid Oxygen Systems – Penetrant materials to be applied to assemblies, subassemblies or components that are to be used with liquid oxygen systems shall be impact sensitivity tested. Only those penetrant materials, which have successfully passed the impact sensitivity tests, shall be used. These may be obtained from the Materials, Processes, and Manufacturing (MP&M) Department.

4.3. Pre-Inspection Cleaning – Assure all scale, rust, acids, chromates, oil, grease, water, and any other contaminants are removed.

4.3.1 Etching-

4.3.1.a. Etching prior to penetrant inspection is normally required on flight hardware. Refer to applicable drawings and specifications. Etching for flight hardware is typically performed by the Engineering Directorate contractor. (Reference W1-09-S3-01 or latest revision for aluminum and stainless.)

4.3.1.b. Etching of carbon steel is not required unless specified in the drawing or work authorizing document.

4.3.1.c. Etching of stainless steel ASME code piping is not required.

4.4. Application Of Penetrants

4.4.1. Surface Preparation – All surfaces to be inspected shall be clean, dry, and free of soils, oils, grease, paint and other coatings, corrosion products, scale, smeared metal, welding flux, chemical residues, or any other material that could prevent the penetrant from entering discontinuities, suppress dye performance, or produce unacceptable background.

4.4.1.1. Cleaning Methods – All cleaning methods,

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chemical and mechanical, utilized including etching shall be consistent with the contaminants to be removed and shall not be detrimental to the component undergoing inspection. The component shall never be cleaned with abrasive material such as shot, grit blasting, and power brushing. Stainless steel brushes should only be used on stainless steel.

4.4.2. Penetrant Application – Unless otherwise specified, the entire surface of the component shall be covered with penetrant. Those areas not to be covered with penetrant shall be masked or otherwise protected. Spraying, dipping, brushing, or other methods to provide coverage as required shall apply penetrant. The component, penetrant, and ambient temperatures shall all be in the range from 40 to 120 degrees F (4 to 49 degrees C) for Type I penetrants or 60 to 120 degrees F (16 to 52 degrees C) for Type II penetrants unless otherwise specified. During the application of the penetrant, if incomplete wetting occurs this may be a sign the component needs additional cleaning. The penetrant should be applied to the area of interest plus at least ½ inch on both sides of the area.

4.4.2.1. Penetrant Dwell Times – The dwell time, unless otherwise specified, shall be a minimum of 10 minutes. The dwell times shown in Table I shall be used as a general rule, unless otherwise specified.

Penetrant Type	Temperature Range	Dwell Time
Type I	40 to 120°F	15 minutes
Type II	60 to 125°F	10 minutes

Table I. Penetrant Dwell Time

#### 4.5. Penetrant Removal

##### 4.5.1. Water-Washable Fluorescent and Visible Dye

Penetrants. Water-washable penetrants shall be removed with a manual or automated water spray, or a manual wipe.

4.5.1.1. Darken the area and use a black light as an aid to visually determine that all penetrant has been removed. Dry the surface using a dry disposable wiper.

##### 4.5.2. Solvent Removable Fluorescent and Visible

Penetrant – Apply by spraying, brushing, swabbing or dipping. After the prescribed soaking time, remove excess penetrant with dry, lint free paper towels or cloths, taking care not to remove penetrant from discontinuities. Remove remaining traces of penetrant with lint free towels or cloths moistened with solvent. Direct spraying or flushing is prohibited.

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#### 4.6. Application of Developer

4.6.1. The developer shall be applied in such a manner that will produce a fairly uniform white coating. Care shall be taken in the application of the developer so as not to apply a coating so thin that the dye will not be drawn out of discontinuities, or so thick that pooling will result and mask indications. Developing time shall be from 7 to 30 minutes, maximum.

#### 4.7. Examination

4.7.1. The true size and nature of discontinuities are difficult to evaluate if the dye diffuses excessively in the developer, therefore, it is good practice to observe the surface being examined during application of the developer in order to detect the nature of certain indications which bleed out profusely.

4.7.2. The examination area shall be clean and free of from fluorescent contamination and residual visible light background.

4.7.3. All black lights, reflectors and filters shall be checked prior to start of surface examination. Reflectors and filters shall be checked for cleanliness and integrity prior to start of surface examination. Minimum acceptable intensity for black lights shall be  $1000\mu\text{W}/\text{cm}^2$  at 15 inches (38.1cm) from the front of the bulb.

4.7.3.1. Type I Processes - Dark adaptation of vision is required for a minimum of 1 minute prior to conducting an examination of components. Photochromic or permanently darkened lenses shall not be worn while processing or reviewing components under black light. All areas of fluorescence shall be interpreted. Components with excessive background fluorescence shall be cleaned and reprocessed.

4.7.3.2. Type II Processes - All indications shall be interpreted. Components with excessive background shall be cleaned and reprocessed.

4.7.4. If the interval between removal of penetrant and examination exceeds 5 hours, then complete reprocessing shall be required.

#### 4.8. Evaluation of Indications

4.8.1. Non-relevant Indications - Any indication that is believed to be non-relevant shall be regarded as a defect until the indication is eliminated by surface conditioning or evaluated by other non-destructive means and demonstrated to be non-relevant. For example, localized surface imperfections such as machining marks or other surface conditions may produce indications similar to those of relevant indications and which may or may not be relevant. Broad areas of pigmentation that would mask indications of discontinuities are not acceptable.

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4.8.2. Relevant Indications - Relevant indications typically result from mechanical discontinuities. Unless otherwise specified, indications with dimensions greater than 1/16 inch shall be considered relevant.

4.8.2.1. Linear indications are those having a length exceeding three times the width of the indication.

4.8.2.2. Rounded indications are those, which are circular or elliptical and have a length of less than three times the width of the indication.

#### 4.9. Accept/Reject Criteria

4.9.1. Accept/Reject criteria shall be noted on the engineering drawings or other approved design documentation provided to the Quality Assurance Specialist (QAS) by the design engineer prior to indication evaluation. In the event that no accept/reject criteria is available the following types of relevant indications shall be considered unacceptable and shall be cause for rejection:

- a. Any cracks and linear indications.
- b. Rounded indications greater than 3/16 inch.
- c. Four or more rounded indications in a line, separated by 1/16 inch or less edge to edge.
- d. Ten or more rounded indications in any six square inches of surface. The minor dimension of this area shall be no less than one inch and the area selected shall be taken in the most unfavorable location relative to the indications being evaluated.

#### 4.9.2. Weld Edge Preparations

4.9.2.1. The following relevant indications are not acceptable:

- a. Laminar discontinuities over one inch or ½ pipe diameter long and other linear indications over 3/16 inch long.
- b. Rounded indications with dimensions greater than 3/16 inch.
- c. Four or more indications in a line need to left justify separated by 1/16 inch or less, edge to edge.

#### 4.9.3. Base Materials and Base Material Repairs

4.9.3.1. The following relevant indications are not acceptable:

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- a. Any linear indications greater than 1/16 inch long for materials less than 5/8 inch thick to under 2 inches thick and 3/16 inch long for materials 2 inches thick and greater.
- b. Rounded indications with dimensions greater than 1/8 inch for thickness less than 5/8 inch and greater than 3/16 inch for thicknesses 5/8 inch or greater.
- c. Four or more indications in a line separated by 1/16 inch or less edge to edge.
- d. Ten or more indications in any 6 square inch of area whose major dimension is no more than 6 inches with the dimensions taken in the most unfavorable location relative to the indications being evaluated.

4.9.4. In the event that no indications are detected, stamp and date the work authorization document, complete the record of penetrant inspection (Appendix A), attach it to the work authorization document, and forward a copy of the record to the Quality Assurance Records Center (QARC), or the Technology Evaluation department electronic Test Preparation Sheet records, as applicable.

#### 4.10. Post Examination Cleaning

After completion of all examinations, the examined areas shall be cleaned by wiping with clean dry wipes, followed by wiping with an appropriate penetrant remover.

### 5. NOTES

5.1. Reference Guideline - ASTM E1417 and E165 may be used to perform penetrant inspection.

5.2. Directive Replacement - This Directive replaces QS10-QA-009 Revision F, "Penetrant Inspection".

5.3. Records are maintained by the Quality Assurance Records Center for flight hardware and by the using organization for test stand and facility hardware.

### 6. SAFETY PRECAUTIONS AND WARNING NOTES

None

### 7. APPENDICES, DATA, REPORTS, AND FORMS

MSFC Form 4457, "Dye Penetrant Weld Inspection Report", Appendix A, "MSFC Record of Penetrant Inspection", or equivalent, will be used to document the results and attached to the applicable work authorizing document.



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## 8. RECORDS

None.

## 9. TOOLS, EQUIPMENT, AND MATERIALS

Materials used for penetrant inspection are shown in Table II (see next page). Quantities and sizes are on an as-required basis except as noted. All items are commercially available.

**NOTE:** Intermixing of penetrant materials from different family groups is not recommended.

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MATERIALS
Water-Washable Fluorescent Dye Penetrant
Solvent Removable Visible Dye Penetrant
Water-Washable Visible Dye Penetrant
Solvent Removable Fluorescent Dye Penetrant
Developer
Solvent
De-ionized or Tap Water
Disposable Wipers, Type 900L, Stock No. 3427, FSN 7920-634-1745
Brush, Camel Hair - 1/2 inch diameter
Measuring Magnifier - 7-10X
Portable Black Light, 3650a - 100 Watt/115 V.A.C.
Cotton Tipped Swabs
Trichloroethylene
Bottle, Polyethylene - 8 oz.
Bottle, Polyethylene - 16 oz.
Measuring Tape - 10 ft.
Measuring Tape - 100 ft.
Kit Container – Nonbreakable, chemical resistant and sized (12” x 18” x 4”), to carry the required materials

**Table II. Penetrant Inspection Materials**

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## 10. PERSONNEL TRAINING AND CERTIFICATION

All personnel that perform penetrant inspection for acceptance of hardware are required to be trained and certified in accordance with **MWI 3410.1**.

## 11. FLOW DIAGRAM

None

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## Appendix A

### MSFC RECORD OF PENETRANT INSPECTION

TPS/WORK AUTH # \_\_\_\_\_ PROG/PROJ: \_\_\_\_\_

INSP. DATE: \_\_\_\_\_

INSP. PROC. #/REV: \_\_\_\_\_ ACCEP. SPEC#/REV. \_\_\_\_\_

PART/WELD# \_\_\_\_\_ DWG# \_\_\_\_\_

PART NAME/DESC.: \_\_\_\_\_

MATERIAL TYPE: \_\_\_\_\_ CLASS# \_\_\_\_\_

PART TEMP: \_\_\_\_\_

PENETRANT METHOD: \_\_\_\_\_ SENSITIVITY LEVEL \_\_\_\_\_

CLEANER MATERIAL: \_\_\_\_\_

PENETRANT TYPE: \_\_\_\_\_ DWELL TIME: \_\_\_\_\_ MIN.

EMULSIFIER: \_\_\_\_\_ DWELL TIME: \_\_\_\_\_ MIN.

DEVELOPER TYPE: \_\_\_\_\_ DWELL TIME: \_\_\_\_\_ MIN.

SOLVENT: \_\_\_\_\_

BATCH #: PENETRANT \_\_\_\_\_ EMULSIFIER: \_\_\_\_\_

DEVELOPER: \_\_\_\_\_

ACCEPT: \_\_\_\_\_ REJECT: \_\_\_\_\_

DEFECT DESCRIPTION: \_\_\_\_\_

INSPECTOR: \_\_\_\_\_ LEVEL: \_\_\_\_\_

EMPLOYER: \_\_\_\_\_

INSPECTOR: \_\_\_\_\_ LEVEL: \_\_\_\_\_

EMPLOYER: \_\_\_\_\_